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Orthographic Depth Modulates Reading Route Selection: An Electrical Neuroimaging Study

Buetler K.[a,*], De León Rodríguez D.[a], Laganaro M.[b], Müri R.[c], Spierer L.[a], Annoni J.[a]

[a] *Laboratory for Cognitive and Neurological Sciences, Department of Medicine, University of Fribourg, Fribourg, Switzerland*
[b] *Faculty of Psychology and Educational Sciences, University of Geneva, Geneva, Switzerland*
[c] *Division of Cognitive and Restorative Neurology, Department of Neurology, University of Bern, Bern, Switzerland*

Introduction

The Orthographic Depth Hypothesis (Katz and Feldman, 1983) posits that different reading routes are engaged depending on the expertise of the reader but also on the type of grapheme/phoneme correspondence of the language being read. Shallow orthographies (e.g. German and Italian) with consistent grapheme to phoneme correspondences favor encoding via non-lexical pathways, where each phoneme is sequentially mapped to its corresponding grapheme. In contrast, deep orthographies (e.g. French and English), with inconsistent grapheme to phoneme correspondences favor lexical pathways, where phonemes are retrieved from memory structures. Only few studies investigated the impact of orthographic depth on brain response while reading. Moreover, because they used between subject or cross-language designs, the interpretability of previous studies on the effect of orthographic depth is limited. The aim of the present study was to investigate the impact of orthographic depth on reading route selection using an experimental design enabling isolating the effect of orthographic depth.

Method

We presented the same pseudowords (PWs) to highly proficient bilinguals and manipulated the orthographic depth of PW reading by embedding them among two separated language contexts (German and French), implicating either shallow or deep orthography. High density 128-channel electroencephalography was recorded during the task.

Results

The topographies of the event-related potential were different between PWs read in deep orthographic context and PWs read in shallow orthographic context at 300-360 ms after stimulus onset, indicating distinct brain networks engaged in reading during this time window. The brain source underlying these topographic effects were located within left inferior frontal, left parietal and left cingular areas.

Conclusion

We propose that in deep orthographic context, reading PWs cannot rely on the routine lexical pathways and thus switching to the non-lexical route is necessary. In contrast, reading in a shallow orthographic context favors non-lexical route processing which fits PW reading. The topographic modulation might thus reflect the recruitment of lexical pathways in the deep but not in the shallow context. Analysis of electrical source estimation over the period of topographic modulation supports this hypothesis by showing that inferior frontal areas, a region shown to subserve phonological processing, is differentially engaged between the deep vs shallow conditions. In addition, a difference in the activity of parietal–cingular areas suggests a modulation of attentional demands related to route selection processes. Non-lexical route may be less automatized than lexical route processing. These collective results support a modulation of reading route selection by orthographic depth.

* Corresponding author.
E-mail address: karin.buetler@unifr.ch .

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